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IGY BULLETIN

A monthly survey by the U. S. National Committee for the International Geophysical Year. Established by and part of the National Academy of Sciences, the Committee is responsible for the U. S. International Geophysical Year program in which several hundred American scientists are participating and many public and private institutions are cooperating.

First US-IGY Satellite

The first US-IGY satellite, 1958α, was launched from Cape Canaveral, Florida, at 10:48 pm EST on January 31, 1958.

Launching: The launching vehicle was a four-stage modified Jupiter-C rocket developed jointly by the US Army Ballistic Missile Agency and the Jet Propulsion Laboratory (JPL) of the California Institute of Technology. The first stage was a modified Redstone rocket with liquid propellants. The second and third stages were composed of clusters of solid propellant rockets, each forty inches long and six inches in diameter.

The upper stages of the rocket were spin-stabilized in order to minimize variations in the direction of travel owing to possible faulty alignments of rocket thrust and unbalance of the assembly. Electric motors were used to spin the upper stages at 450 rpm before take-off. After take-off the spin was increased to 700 rpm.

The over-all length of the composite vehicle is 823.3 inches. The first stage, 672.8 inches long and 70 inches in diameter, separated from the upper section at an altitude of 53 miles, when its fuel was expended, and fell into the Atlantic. The upper stages coasted to an altitude of 230 miles. At the apex of the arc, when the rocket's path was approximately horizontal, the high-speed stages were fired in sequence, increasing the orbital speed of the satellite to approximately 18,000 mph.

Satellite Characteristics: The final stage of the Jupiter-C, which carries the scientific instrumentation, is 80 inches long, six inches in diameter, and weighs 30.80 pounds after burnout (see Fig. 1). The instrument payload, carried in the forward section, weighs about 11 pounds. The protective instrument case of stainless steel weighs 7.5 pounds with an inner liner of fiber glass. The forward part of the instrument case is painted with stripes of aluminum oxide, designed to control the radiative properties of the surface and maintain the interior at a reasonable temperature. Four whip-like antennae extend from the mid-section of the satellite.

Instrumentation: The satellite carries instrumentation to measure the total cosmic-ray intensity, density of meteoric matter in the satellite's orbit, and measurements of temperature both within and at the skin of the satellite.

Cosmic rays are measured by a Geiger counter. The impact of solid meteoritic particles is measured in two ways: by a microphone which picks up the actual sound of particles hitting the satellite shell, and by erosion gauges which change their electrical characteristics when broken or eroded by contact with small particles.

Thermal probes measure the temperature in the interior of the satellite and next to the outside skin.

Two radio transmitters are carried. One

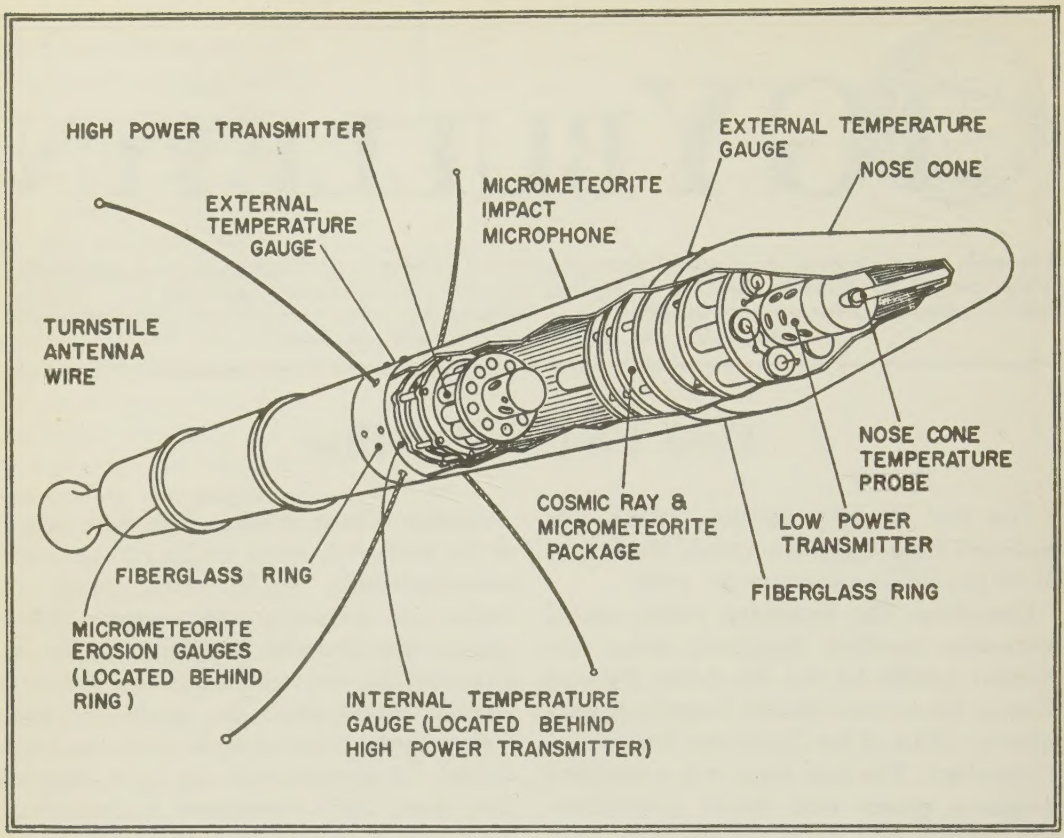

Fig. 1. *US Earth Satellite 1958α. Satellite consists of final stage of rocket vehicle with scientific and telemetry instruments.*

radiates approximately 60 mw of power on 108.030 mc. This transmitter ceased operating during the 12th day of orbit and unexpectedly resumed transmission on February 24th. The other transmitter, radiating 10 mw of power on 108.000 mc, the primary tracking frequency, is designed to operate for approximately two months. Both transmit telemetry data on instrument readings. (A detailed description of the telemetry system was given in *Bulletin No. 8.*)

Observations: The two US radio observation nets, the prime system, Minitrack, and a supplemental system, Microlock, have tracked the satellite and have received telemetry data on every pass. The Minitrack stations utilize comparison of the phase of 108.000-mc signals arriving at different antennas to obtain the angular altitude and azimuth of the satellite. Seven Minitrack stations are stretched approximately along the 75th meridian in a "picket fence" from Blossom Point, Maryland, to Santiago, Chile. Other Minitrack stations are located at Antigua, in the Caribbean; San Diego, California; and Woomera, Australia (see *Bulletin No. 2* for a more complete description of Minitrack). The Microlock stations are at Cape Canaveral, Florida; Ibadan, Nigeria; Singapore; Earthquake Valley near San Diego, California; and Temple City, California. The stations at Ibadan and Singapore are used for telemetry only.

Although visual observations from the United States were not expected, a telescopic sighting was reported by a Moonwatch team at Alamagordo, Mew Mexico, on Saturday, February 1, and a naked-eye sighting by a Moonwatch team in Manhattan, Kansas, on Sunday, February 2.

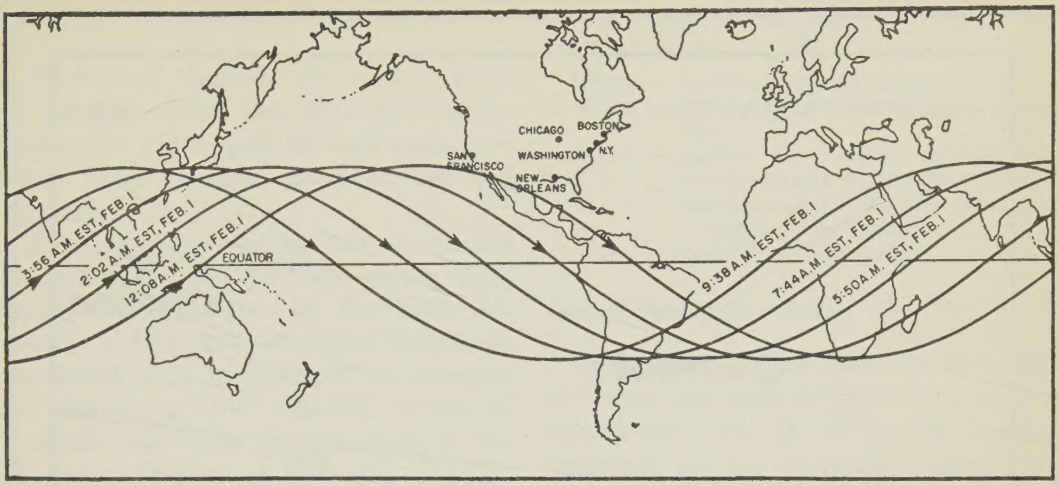

Fig. 2. *Predictions of Orbits of US Earth Satellite 1958α for the Morning of February 1, 1958. Compiled by the Naval Research Laboratory, Washington, D. C.*

The Manhattan team estimated the satellite to be as bright as a fifth-magnitude star.

Orbit: Following is the orbital information on 1958α as sent to the Special Committee for the IGY (CSAGI) of the International Council of Scientific Unions, by the USNC-IGY on February 6, 1958:

"Following orbital elements obtained by NRL from analysis 31 Minitrack observations covering first 32 revolutions 1958 Alpha. Elements include influence general perturbations and are for 0358 Zebra February one. Minimum height above earth's surface 219 statute miles maximum height 1587 statute miles period 114.95 minutes eccentricity 0.14052 inclination 33.58 degrees ascending node longitude 342.95 degrees with motion minus 4.26 degrees per day perigee argument 120.76 degrees with motion plus 6.31 degrees per day mean anomaly at epoch 14.68 degrees semi-major axis 1.2278 earth radii ascending node longitude 88 degrees 47 minutes 16 seconds East at Feb. 050647 Z, westward motion of the equatorial node is 29.13 deg. per period." (See Fig. 2.)

Phototrack

The program for volunteer photographic observations of earth satellites noted briefly in *Bulletin No. 6, December 1957*, has been formally endorsed by the USNC-IGY and is now designated program "Phototrack." Phototrack observations are expected to make a valuable supplemental contribution to the prime optical tracking network of Baker-Nunn cameras.

This program is actively supported by the Society of Photographic Scientists and Engineers (SPSE). It is designed to obtain satellite photographs meeting these specifications: Negatives are to be at least 4″ by 5″ and should be taken with a lens of at least 5″ focal length; they are to show the track of the satellite orbit against a fixed starfield background (see Fig. 3); and the trace of the satellite orbit is to contain two gaps, or displacements, timed to an accuracy of 0.1 second.

The order of accuracy of observations made to Phototrack specifications is quite high. Although the accuracy of determination of the satellite's position along its path is limited by the timing accuracy, the

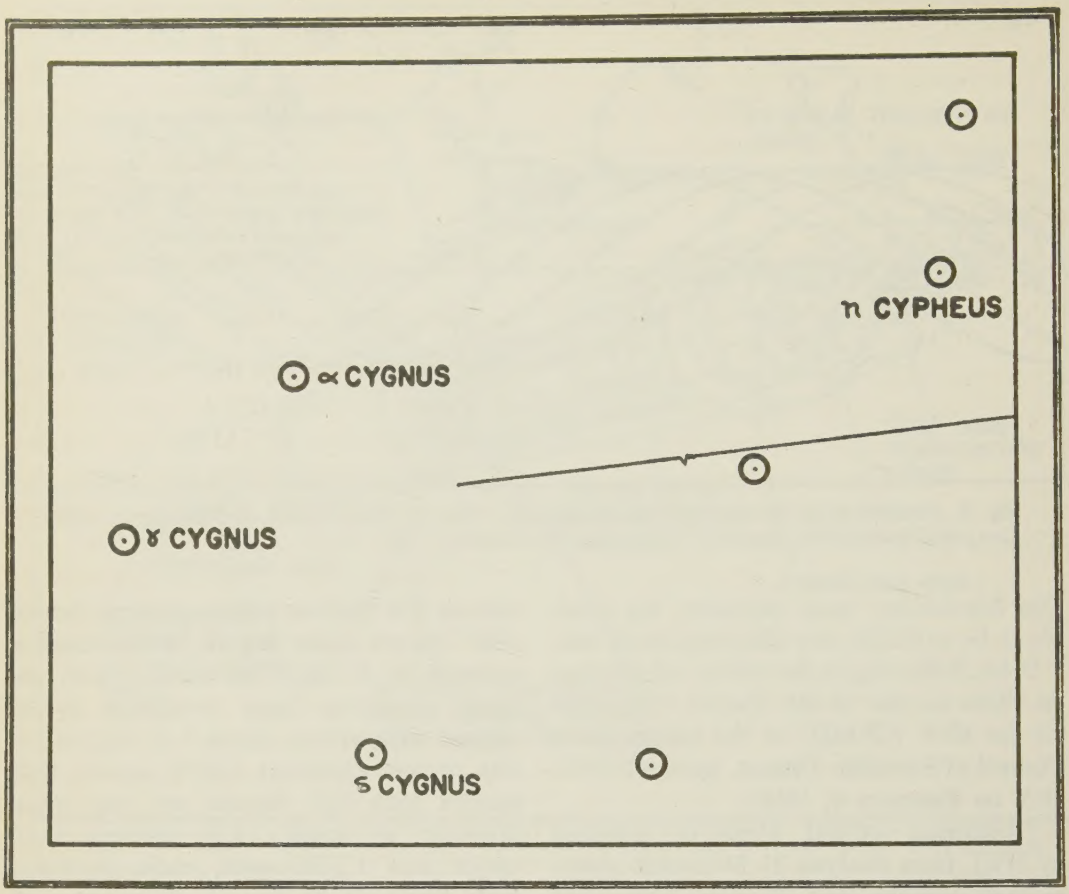

Fig. 3. *Representation of Phototrack Print Showing Track of Earth Satellite 1957β Against Fixed Starfield Background. Break in track indicates point at which camera was rapped. Taken by L. W. Tregillus, Rochester, N. Y., with a Zeiss camera having an f/6.3 Tessar lens with a focal length of 165 mm. The Kodak Royal-X emulsion was developed in DK-60 developer for 6 min at 75°F.*

position of the path itself can be determined to within 50 yards. Discrepancies of this magnitude in the satellite's predicted path can disclose information on the relative positions of the continents and on the size and shape of the earth. In addition, air drag affects the satellite's orbital period, which in turn critically affects the longitudinal changes in the satellite's apparent path over the earth. Thus, it may be possible to obtain useful air density data from measurements of the path position recorded on a Phototrack negative.

Evaluation tests are planned for improving the Phototrack technique and determining its ultimate capability.

Emulsions and Lenses

Fast emulsions must be used in Phototrack observations. Emulsions with ASA indexes of 200, developed in DK-60 for 5.5 minutes at 68°F, have recorded phototracks of 1957α1 and 1957β. These photographs were taken with lenses having apertures of less than one inch. By using the new superfast emulsions, forced development techniques, and lenses with apertures on the order of four inches, it is hoped that photographs may be obtained of objects comparable in brightness to 1957α2, which was reported to be 25 inches in diameter.

Communications for Prediction Data

Phototrack observers will need to know in advance what the optimum camera orientation will be and, in some cases, precisely when to begin, interrupt, and end exposure.

Every weekday evening since November 26, station VPZ, the Air Force station of the national headquarters of the Civil Air Patrol (CAP), has broadcast Phototrack acquisition data forecasts. These forecasts are relayed on CAP channels to the individual CAP wings and squadrons in the 48 states, District of Columbia, Hawaii, Puerto Rico, and Alaska. Should there be groups in other areas desiring to participate in the Phototrack program, efforts will be made to arrange appropriate communications through the cooperation of the IGY World Warning Agency and the cognizant IGY Participating Committee. The communications arrangements within the United States itself are presently being modified to include twilight, eclipse, and radio tracking information for satellites whose orbits are inclined at any angle to the equator. The modification will enable the CAP communications network to serve the needs of Phototrack; the visual tracking program, Moonwatch; the volunteer radio tracking program, Moonbeam; ionospheric stations; and interested newspapers within the United States.

The CAP messages will be given in the following form (The information in brackets is given only when the vertex of the track is above 40°N latitude):

On (Day) (Month) earth satellite 195– —— will be ——— statute miles high and condition *(Green) (Red) (Black) (White) proceeding along curve (Inclination) (Period) [heading ——— degrees across fortieth parallel] and transmitting on ——— megacycles.

Vertex [fortieth parallel intercept] —— degrees west at —— Eastern Standard Time leaving condition (Black) (White) at —— degrees west at —— EST entering condition (White) (Black) at —— degrees west and —— EST.

*Black = satellite in earth's shadow.
White = satellite and satellite subpoint in sunlight.
Green = satellite in sunlight, satellite subpoint in earth's shadow (the necessary condition for visual observation of non-luminous satellites).
Red = satellite self-illuminated.

Use of Prediction Data

On any satellite pass there will be a point of nearest approach (PNA) and a time of nearest approach (TNA) to the station. Optimum camera orientation passes the camera axis through PNA, and optimum time for interruption is at TNA.

A plotting board may be prepared by placing a transparent sheet over a map or mosaic of maps showing all territory within at least 600 miles. The trace of the predicted transit can then be marked on the board with a grease pencil.

An alternative method, using a preplotted curve on a latitude-longitude grid, has been developed. Details and instructions on the use of this method are being furnished to participants in Phototrack and other volunteer observational programs.

A perpendicular line from the station position to the satellite trace will intersect the latter at the ground point beneath the PNA. The direction of the perpendicular line from the station point is the optimum azimuth for camera orientation. The length of the perpendicular line from the station to the sub-satellite point at PNA represents the distance between the station and the sub-satellite point. This is called "distance of nearest approach" (DNA). This distance can be expressed in miles or in degrees.

When the DNA and the satellite's height above the earth in kilometers or statute miles are known, camera elevation in degrees above the horizon can be determined through use of tables of elevation furnished

to Phototrack observers by the SPSE or by making a trigonometric calculation.

Method of Making Exposure

The Phototrack exposure should begin as the satellite enters the camera's field, be interrupted or displaced twice as it passes along the central portion, and end as it leaves. The time of nearest approach (TNA) for a properly oriented camera would correspond to the time the satellite crossed the center of the field. When the satellite is bright enough for visual observation, the beginning, interrupting, and ending of exposure can be programmed for visual control. There may be times, however, when the satellite may be bright enough to make a Phototrack record but too faint for visual control of exposure. In such cases, the TNA must be computed in advance, and a preprogrammed beginning, interrupting, and ending carried out "by the clock."

The SPSE is furnishing all participants in the Phototrack program with detailed instructions on making, timing, and identifying the photographs. Each negative taken

DO NOT WRITE IN THIS SPACE

Forward negative to: SPSE, 826 Connecticut Ave., Washington 6, D.C., U.S.A.

EARTH SATELLITE _____ No. 195( )_____

TRIANGULATION STATION NAME* _____

COUNTY _____ STATE _____

Date of Observation _____, 195( )

LONG INTERRUPTION†, From ____:____:____ to ____:____:____ ( )st

ESTIMATED AZIMUTH _____, ELEVATION _____

(please mark "top" on appropriate margin of negative)

Lens Type _____, f _____, Focal Length _____mm

Emulsion _____ Developer _____,

Developed for _____ minutes, at _____ F.

Observer's Name _____

Address _____

_____

* For location of nearby USCGS triangulation Station markers consult local surveyor's office.

† Portable radio must be tuned to Station WWV broadcasting on 5, 10, 15, 20, 25, or 30 megacycles (or equivalent), for beginning interruption at a time that is accurate to within one-tenth second.

Society of Photographic Scientists and Engineers form ES-1

Fig. 4. *SPSE Form ES-1. These forms are designed to accompany phototrack negatives giving pertinent information on location of observation, exposure, and development.*

will be filed in a jacket with a gummed label giving pertinent information on location, exposure, and development (see Fig. 4, SPSE Form ES-1).

To establish the time of a Phototrack observation to the required accuracy, the National Bureau of Standards' time signals, broadcast by station WWV on 5, 10, 15, 20, 25, and 30 mc, may be used.

Where the observation station is remote from standard 60-cycle power, a team of observers, using a portable receiver tuned to Station WWV can come reasonably close to the desired degree of accuracy. If one observer keeps track of time by counting time ticks, the other can drop a dark slide before the lens synchronously to a time tick and hold it there for several seconds. Positive manual cut-off with the slide is preferred to use of the shutter, which is bound to introduce time-delay uncertainties.

Where 60-cycle power is available, the SPSE recommends that an auxiliary camera be set up to photograph the time on a large synchronous electric clock. If possible the clock should be mounted in the center of a blackboard so that the date, geographical position, and other observational data can be recorded on the same negative (see Fig. 5).

The clock is photographed three times on the same negative by firing an electronic flash unit. The Phototrack camera and the flash unit are wired together in such a manner that striking a metal part of the Phototrack camera or tripod with a metal striking tool completes the circuit to fire the flash. Striking the camera also displaces the traces of the satellite and the stars on the Phototrack negative.

Prior to the predicted time of the satellite passage the clock is synchronized with WWV, working lights are turned off, the flash unit energized, and the cameras opened.

When the satellite image approaches the

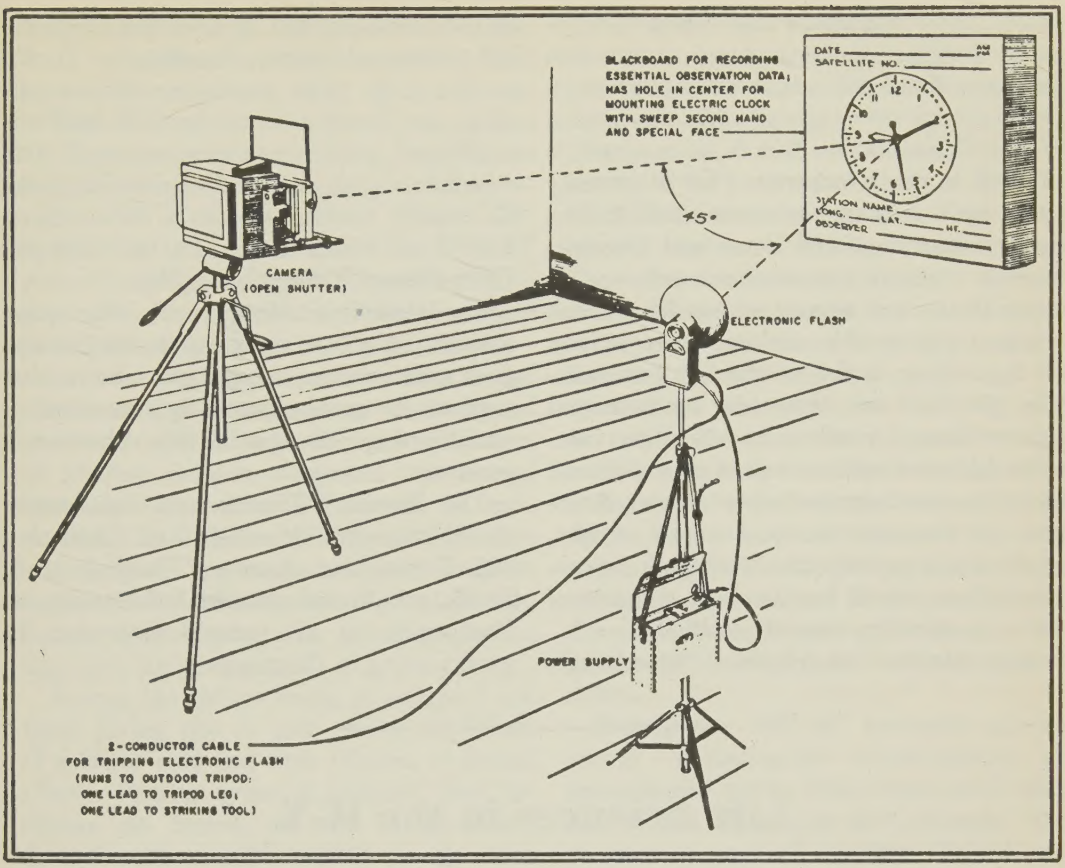
BLACKBOARD FOR RECORDING ESSENTIAL OBSERVATION DATA; HAS HOLE IN CENTER FOR MOUNTING ELECTRIC CLOCK WITH SWEEP SECOND HAND AND SPECIAL FACE
DATE
SATELLITE NO.
STATION NAME
LONG. LAT. HT.
OBSERVER
45°
CAMERA (OPEN SHUTTER)
ELECTRONIC FLASH
POWER SUPPLY
2-CONDUCTOR CABLE FOR TRIPPING ELECTRONIC FLASH (RUNS TO OUTDOOR TRIPOD; ONE LEAD TO TRIPOD LEG; ONE LEAD TO STRIKING TOOL)

Fig. 5. *Auxiliary Camera Set Up to Photograph Precise Times of Breaks in Satellite's Track Shown on Phototrack Negatives.*

center of the field of the Phototrack camera, the observer raps the grounded part of the camera or tripod with the rapping tool, then does so again. After the Phototrack exposure is completed, the timing flash is fired again, this time synchronously with the fifth tick following the double tick of WWV.

The three superimposed images of the clock face will show three different, distinguishable times. The last recorded time, being accurately keyed to the end of the fifth second by station WWV, will permit reading-out any synchronization error so that the interruption times may be given to better than the required accuracy of $\frac{1}{10}$ second.

Striking the camera or tripod during exposure will produce a displacement of the satellite image, thus sharply interrupting the streak. It is unlikely that the fixed-star traces will settle down to where they left off before the tap, or that the satellite streak will continue in precisely the same line. The result will be three segments of satellite streak related to three mutually displaced sets of star traces. The shortest (middle) streak, however, can readily be related with precision to the faintest (and shortest) set of star traces. The means employed for producing the discontinuities and for recording their times are positive, do not require calibration, and supply the data in a self-evident form.

Location of Phototrack Station

By itself, a perfect Phototrack negative, together with its chronograph negative,

would not constitute a significant observation. Location of the point of observation in three dimensions must also be given in such a way as to tie in with the United States Triangulation Net or to comparable surveys in other countries. This is normally done by surveying the observation station as an offset to a US Coast and Geodetic Survey triangulation station marker or its equivalent. In summary, a Phototrack station requires (1) a "closed loop" survey of its location tied into the US Triangulation Net with not more than one foot total error—though observations will still be valuable if located with errors not exceeding 100 ft.; (2) an unobstructed view of most of the sky; (3) freedom from local sources of light, particularly passing auto headlights; (4) accessibility; and (5) location near a source of 60-cycle electric power, if possible.

Appropriate topographic "Quadrangle Sheets," which may be obtained from the US Geological Survey, Washington, D. C., or found in most surveyor's offices, will show the location of nearby USC&GS triangulation station markers as small dots within triangles, and of nearby bench marks as crosses next to elevation data. About half of all bench marks are tied into the United States Triangulation Net.

The American Congress on Surveying and Mapping is encouraging its members to give assistance in surveying-in observation stations for groups genuinely interested in participating in the SPSE Phototrack program.

The Secretary-Treasurer of the Society of Photographic Scientists and Engineers, 826 Connecticut Avenue, Washington 6, D. C., will furnish detailed information on Phototrack to all persons interested in participating in the program.

Life Sciences in the IGY

While the International Geophysical Year is by definition concerned with studies in the physical sciences, the USNC-IGY has recognized that its program includes activities in relatively inaccessible regions. Therefore, research workers in the life sciences have been encouraged to take advantage of the unique opportunities provided by the IGY program and to use IGY facilities for work in their own disciplines.

Marine biology studies are conducted on all IGY oceanographic cruises (for examples of the type of work done, see the report of the "Cruise of the Brown Bear" in this issue.) Investigations in dentistry, human and animal physiology, psychology, botany, and animal migration are being conducted at US-IGY Antarctic Stations. At US-IGY Arctic Drifting Stations A and B, continuing investigations in marine biology, with particular reference to microorganisms and nutrition supply, are carried on. Even the earth satellites will be used for basic biological research. It is planned to place small living organisms, in the form of yeast, in one or more of the test spheres launched in the Vanguard program.

Brief outlines of the main problems being studied at Antarctic and Arctic IGY stations and the methods of attack on these problems are given below.

Antarctic

Dentistry: Experience on past polar expeditions indicates that dental disorders are among the most troublesome problems encountered in extreme cold. The most usual malady encountered is toothache. All devitalized and carious teeth become painful, often requiring extraction. When cold air is brought in contact with diseased teeth, the pain is often considerable. As the

cold increases, alloy fillings appear to contract and pull away from the cavities they protect. Some fall out, while others leak, resulting in decay beneath the fillings. Front teeth, particularly those having large fillings and gold inlays, become quite painful on exposure to low temperatures. These difficulties have been encountered in the US-IGY Antarctic program despite attempts to prevent them by examination and treatment prior to departure from the United States.

In view of these cold-weather dental problems, the Committee on Dentistry of the National Academy of Sciences, Division of Medical Science, suggested that dental research during the IGY should be considered. The US Navy's Bureau of Medicine and Surgery has requested Navy dentists stationed at Little America and McMurdo Sound to undertake such investigations as time and facilities permit.

Among the factors being investigated are those giving rise to pain under conditions of extreme cold and their relation to dental effects. Various types of material used for fillings are tested, as well as protective devices such as rubber teeth guards worn by athletes. Temperature changes in the mouth are being measured under a variety of conditions. The relationship of dental complaints to psychosomatic factors (e.g., stress and incidence of medical complaints) is being studied.

Human Physiology: The human physiology program emphasizes the unique conditions confronting US-IGY Antarctic personnel with regard to climate, length of stay, and related factors. The degree of cold exposure is likely to be more severe than anywhere else in the world. The duration of stay is sufficiently long to uncover major trends in physiological readjustment, if such occur. The location of stations, from sea level to an altitude of about 9,200 feet, offers an opportunity to compare the effect of cold by itself with cold plus altitude on man's ability to adapt to his environment.

Work on these questions is being conducted at the Little America Station by a physiologist from the US Air Force Arctic Aeromedical Laboratory, Fairbanks, Alaska. The medical doctor at this station is assisting in the program. At each of the other US-IGY Antarctic stations the station medical doctor is carrying out basic physiological measurements.

Physiological measurements include changes in thickness of body fat, heat production, mobility of joints, and touch discrimination. Measurements are being made on personnel whose duties involve a maximum of out-of-door work, as well as others whose duties require a minimum of outside work. These measurements will be compared. Important correlative data are being obtained by various tests on physical fitness and on increase or decrease in cold injury and its relationship to these measurements.

During the 1957–58 Antarctic summer period, physiological investigations are being carried out by Nello Pace and William Siri of the University of California. This program is part of the joint British and United States Medical—Physiological Expedition and is under the auspices of the U. S. Office of Naval Research and the British Medical Research Council. Particular attention is being paid to the various traverse parties.

Psychology: It is clear from studies of situations involving stress, isolation, and deprivation that individuals respond very differently to such situations. Definitive data for the indoctrination of men going into such situations are lacking. The psychological research program has as its aim the collection of historical data of reasonably intimate personal significance by two methods: written diaries and voice recordings. These data are being collected from personnel at the IGY Amundsen-Scott South Pole, Byrd, Wilkes, and Ellsworth IGY stations.

The Program is under the direction of the

Division of Neuropsychiatry, Walter Reed Army Medical Center, and the Navy Bureau of Medicine and Surgery. Diaries have been given to personnel at these stations and they have been requested to record difficulties in adjustment to weather, limited space, and chores, as well as methods found useful for improving the situation or facilitating adjustment. Attitudes toward problems in the use of equipment and toward work progress, relations to, and importance of, radio communications with other bases and with home, and the kinds of news that seem important, are also being noted.

Development and changes in sub-group relationships, changes in informal organization of the station group, major topics of conversation, incidents of irritability and their management, complaints, distribution of activity, and attitudes toward the sense of passage of time are also being recorded by personnel, both in diary form and on records.

Subsequent analysis of these data by the Division of Neuropsychiatry, Walter Reed Army Medical Center, and the Navy Bureau of Medicine and Surgery will, it is hoped, provide a clearer picture of individual reactions and of group relations under conditions of isolation and stress.

Botany: George A. Llano, Arctic Institute of North America, is making a study of the relationship of the present vegetation of the Antarctic, specifically the lichens, to ice and snow terrain and to fluctuations in the extent of glaciation. He has made collections at McMurdo Sound, Hallet Station, and Wilkes Station.

Animal Physiology: Frozen whole specimens of Adelie and Emperor penguins are being returned from Wilkes Station for study of the anatomy of their respiratory systems.

A telemetering device is in use at Wilkes Station which, when placed inside the egg of a penguin, skua, or other bird, broadcasts the temperature to a recording mechanism. This program is under the direction of Carl Eklund, Wilkes Station Scientific Leader, and will be continued by Willis Tressler, his relief.

Animal Migration Studies: This program was initiated by Carl Eklund at Wilkes Station and will be continued throughout the coming season.

The migration and distribution of the Antarctic skua is under investigation by means of colored plastic bands attached to the legs of these birds. Personnel manning stations of other countries participating in the IGY Antarctic program have been supplied with bands of a distinctive color, so that subsequent observations will give information on the points of origin of banded birds.

Seals are being marked at Wilkes Station by means of a branding iron bearing the initials IGY. Personnel at coastal stations have been alerted to record the appearance of these seals.

Arctic

Sea Ice Studies: It is planned to study the physiology of frozen organisms, including cytological studies of organisms that survive seasonal freezing in sea ice, to determine the mechanisms which enable such organisms—diatoms, protozoans, and higher forms—to survive. In relation to this study, gas diffusion through sea ice, using the Scholander and Evans method and with emphasis upon CO_2, N_2, and O_2, will be investigated.

The solubility of nutrients in sea ice, e.g., O_2, CO_2, PO_2, NO_2, and NO_3, will be studied, as well as the activity of bacteria in sea ice, mechanical effects of freezing on organisms, and respiratory exchanges of frozen organisms.

Marine Biology: At drifting stations A and B the program in marine biology will include periodic sampling and preservation and examination of phytoplankton, zooplankton, and allied life forms.

Cruise of the Brown Bear

This report is based on material furnished by Robert G. Paquette, Department of Oceanography, University of Washington.

The study of the deep currents of the oceans is one of the primary objectives of the IGY oceanographic program. Little is known about the circulation of the deep waters, yet a knowledge of the heat exchange involved in the movement of water between low and high latitudes may be of great importance in long-range weather forecasting. Also, the rate of exchange of mineral-rich deep water with surface water determines the fertility of the oceans and sets a limit on the amount of food man can take from them.

As part of the IGY study of the deep waters, scientists aboard the oceanographic vessel *Brown Bear*, of the University of Washington, conducted investigations during July, August, and September 1957 in the Aleutian Trench, the Aleutian passes, the Bering Sea adjacent to the Aleutian Islands, and parts of the Northeast Pacific. Thirty-six oceanographic stations were occupied during the cruise.

Four of the stations were reoccupations of stations made by the non-magnetic ship *Carnegie* in 1929. In 1958, the *Brown Bear* will reoccupy seven of the *Carnegie* stations, thus making possible studies of changes in the observed phenomena in time as well as in space. Fig. 6 shows the route of the *Brown Bear* in 1957 and the stations occupied, the cruise proposed for the *Brown Bear* in 1958, and the stations occupied by the *Carnegie* on its cruise VII, 1929.

The major IGY objective of the 1957 cruise was to gather data for a north-south profile of water properties extending from the surface to or near the bottom. On most stations, chemical and temperature measurements were taken from the surface to the bottom. Eleven samples were taken from deep and surface waters for dating by the carbon-14 method. A second major objective was a preliminary survey of the circulation of water through the Aleutian

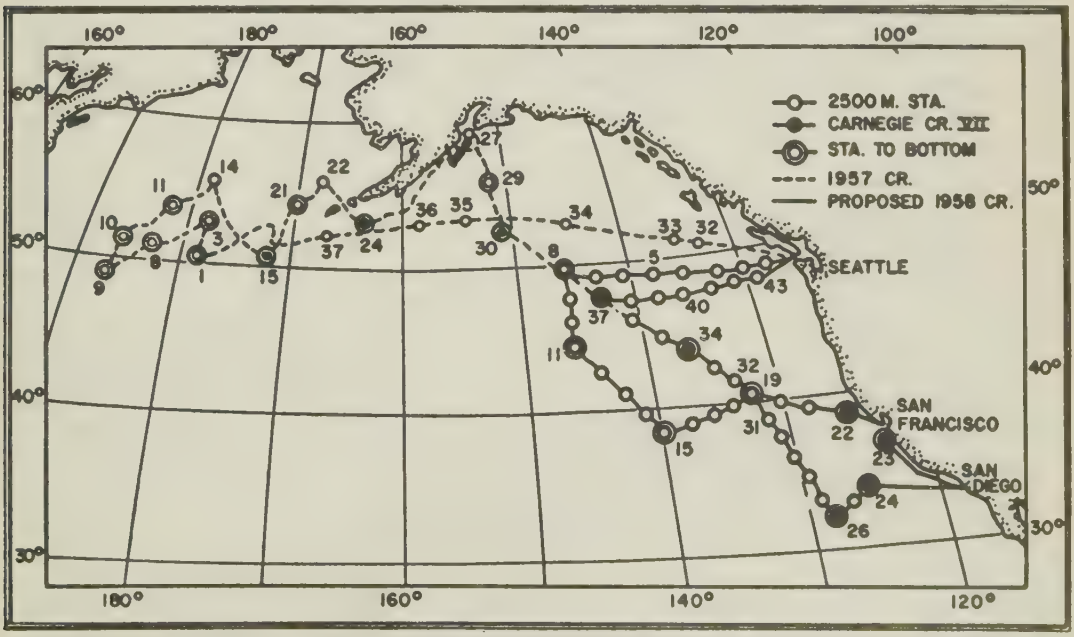

Fig. 6. *Chart Showing the Tracks of the 1957 and Proposed 1958 Cruises of the University of Washington Oceanographic Vessel* Brown Bear. *Black dots represent stations occupied by the nonmagnetic ship* Carnegie, *in 1929.*

passes as observed by a series of station sections through the passes.

Other objectives included:

1. Dating of the deep water by C^{14} methods.

2. A program of special chemistry including determination of silicate, pH, alkalinity, total phosphorus, particulate iron, manganese, calcium, and boron.

3. Routine productivity determinations by C^{14} methods, both underway and on station.

4. Direct measurement of currents north of Kodiak Island—in Shelikof Strait and on the shelf to the south. Both sets of observations were to continue for 29 hours to obtain an indication of the net current flows in these regions, which cannot be studied by the usual dynamic methods. Net flows in these areas may be important in the water-transport budget of the Gulf of Alaska.

Routine observations included salinity; temperature; oxygen; dissolved inorganic phosphate; bathythermograms and associated weather data; bathymetry; and a few bottom cores. A numerical summary of the observations made on the cruise is given in Table 1.

Although biology is not one of the primary IGY disciplines, most IGY oceanographic vessels conduct biological investigations. The *Brown Bear* made a total of 149 hauls with a 6-foot Isaacs-Kidd midwater trawl at depths ranging from about 20 to 275 meters. The hauls were made, weather permitting, along the regular cruise track. A fair number of species of rare, deep water fish were taken. A note-

Table 1. *Numerical Summary*

		Number:
Stations Occupied:		
6000–7280 meters		5
4000–6000 meters		1
2000–4000 meters		6
0–2000 meters		24
Chemical Samples Taken:		
Salinity 742 + 165 (time series)		907
Surface salinity, not including stations		367
Oxygen		731
Dissolved inorganic phosphate, not including duplicates		734
Silicate, spectrophotometric (El Wardani)		500
Silicate, by Nessler tubes (Gast)		144
pH		506
Alkalinity		506
Particulate iron and manganese		137
Calcium and boron		216
Boron and iodine (Gast and Barkley)		144
Total phosphorus	approx.	200
50-gallon samples for age-dating:		
a. surface		6
b. deep		5
Bathythermograms:		
450 feet or less		248
900 feet nominal		189
Plankton Hauls (exclusive of midwater trawls):		
Half-meter net, vertical from 400 meters (No. 6 mesh)		21
Half-meter net, vertical from 200 meters (No. 6 mesh)		21
Half-meter net from shallower depth		2
Clarke-Bumpus sampler, oblique from 200 meters, (No. 6 mesh)		21
Midwater trawls		149
Secchi Disc Observations		16
Carbon-14 Productivity		110
Time Series:		
Currents, salinity, temperature, bathythermograms		2 × 30-hrs.
Individual Current Measurements		228
Bottom Cores with 2-Foot Gravity Corer		6

worthy catch was two eel larvae still in the leptocephalus stage. At the time of capture they were alive and, except for their eyes, transparent. This may have been the first capture of this animal in the area.

Wildlife observations were made continuously and the scientific watch made an entry on a special wildlife-observations form once during each watch. These observations were supplemented by observations of the pilot house watch and by nightlight studies carried out on station when sea conditions permitted. Wildlife observed included whales, porpoises, seals, birds, surface fish, and floating organisms.

Hydrographic observations in the physical oceanographic program were analyzed and the results entered on punch cards while still at sea, thus making the data available for further analysis by machine methods soon after the ship's return to port.

Preliminary results of the program as deduced from the data at this state are:

1. The Aleutian passes are regions of high currents, where powerful upwelling and mixing processes are evident on the bathythermograms to depths as great as about 275 m. Abrupt decreases in temperature as great as 10°F appear at the surface. The modified water is readily evident at distances of 30 miles from the passes, and more subtle effects probably exist at greater distances.

2. Along Shelikof Strait, a net flow was found at all depths, setting southwest with average magnitude about 0.5 knot. This may account for a sizable fraction of the inflowing water in the Alaskan gyral.

3. The currents on the shelf south of Kodiak were rotary. Net flows, if any, were not well defined.

4. Below 2000 m the waters of the Aleutian Trench are very nearly the same throughout. One exception was noted, however: the oxygen concentration at Station 10, at the extreme westerly end of the track, is lower by about 0.015 milligram-atom per liter than at Station 15, in the central portion. Correspondingly, the temperature at the western end is higher by 0.02° to 0.10°C. Temperature increases by 0.05° to 0.20°C and oxygen decreases by 0.03 to 0.05 milligram-atom per liter along the clockwise arc from Station 15 to Station 31. Station 8 is anomalous in having the highest oxygen concentration of all stations in the Trench. Below 6000 m the temperature profiles at the several stations in the Trench are not significantly different. In contrast to the temperatures, the differences in oxygen concentration are maintained all the way to the bottom.

5. In the Trench, the oxygen concentration reaches a maximum of about 0.33 to 0.35 milligram-atom per liter at about 6000 m. It then decreases about 0.025 milligram-atom per liter towards the bottom. This latter effect may be caused by reaction of the oxygen with the metal of the bottles during the long hauling period.

6. The three deeper stations in the Bering Sea (Stations 3, 11, and 21) were very similar in temperature and oxygen concentration, and were 0.08° to 0.12°C warmer and 0.05 to 0.08 milligram-atoms per liter less concentrated than Station 15.

7. The minimum temperature in the Trench is 1.44° to 1.47°C at about 4000 m. Below this depth the gradient with depth is close to the adiabatic.

8. The salinity below 6000 m was found to be lowest at Station 15, 34.691%, and greatest at Station 10, 34.698 to 34.706%.

The Microbarovariograph: A New Instrument For Measuring Minute Atmospheric Pressure Variations

The following material was supplied by William L. Donn, Lamont Geological Observatory.

Studies of the interactions between the atmosphere and hydrosphere are essential to an increased understanding of the earth's heat and water budget. Such studies are, therefore, an integral part of the IGY program. (See *Bulletin No. 2, August 1957.*) In order to facilitate investigation of these interrelationships, instrumentation producing data which can be readily coupled with data obtained for related studies in the allied discipline are sought by both meteorologists and oceanographers.

Meteorologists have long felt a need for a simple, compact ultra-sensitive barograph that would respond to small changes of pressure over any given range. Such an instrument, the microbarovariograph, has been developed by the Lamont Geological Observatory of Columbia University for use in the IGY island observatory program. The instruments will be located near long-period ocean wave recorders in order to study the effects of air-to-water energy coupling.

Basically, the microbarovariograph pressure unit is designed to study: (1) propagation of internal waves in the atmosphere, and (2) the phenomena of wave coupling between the atmosphere and oceans.

The passage of internal waves along an atmospheric discontinuity aloft produces surface perturbations in pressure and wind. The wind effect is difficult to isolate if the ambient wind is strong, but the pressure variations can be recorded easily by the microbarovariograph, permitting study of the velocity and propagation direction of the waves aloft. Moreover, under the proper conditions, violent natural and artificial disturbances can be detected by an array of these instruments at a great distance from the event. Such information is of great value in understanding the dynamic structure of the atmosphere.

Strong marine or lake storm surges have occurred from the effects of coupling to corresponding surges (often waves) in the air. These severe disturbances can usually be detected by conventional instruments

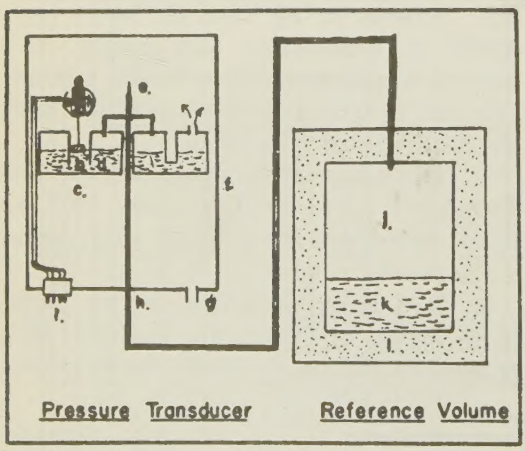

Fig. 7. *Schematic Diagram of Microbarovariograph Transducer. Legend: a. electromagnetic pickup; b. cork float; c. compliance chamber; d. Di-Octal Sebacate; e. slow leak; f. metal cover; g. fast leak; h. plastic tubing; i. electrical connector; j. reference volume; k. calcium chloride solution; l. thermal insulation.*

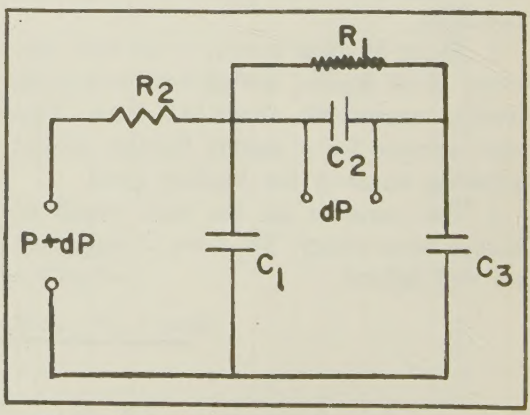

Fig. 8. *Electrical Analog. Legend: R_1. fast leak (short-period response); R_2. slow leak (long-period response); C_1. compliance chamber; C_2. compliance of liquid; C_3. compliance of reference volume; P. ambient atmospheric pressure; dP. signal pressure.*

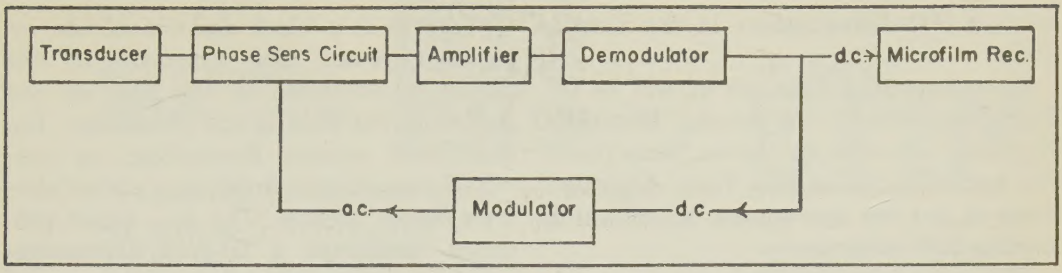

Fig. 9. *Block Diagram of Microbarovariograph Recording System.*

but are too infrequent to provide adequate data for complete study. The sensitive microbarovariograph used in conjunction with a long-period wave recorder permits study of less pronounced but scientifically important cases of coupling. From these a better understanding of the energy transfer between sea and air can be gained.

The instrument is also excellent for the study of short-period turbulence in the air; its response shows every gust of wind. It also shows long-period pressure variations and, owing to its ability to record thermal effects, on clear days it can be used to mark the approximate times of sunrise and sunset.

A record of small amplitude, long-period pressure changes will be of particular value in the study of tsunami waves (so-called tidal waves produced by submarine earthquakes, landslides, or volcanic action) since it is expected that pressure oscillations in the atmosphere will affect the long-period wave record. In tsunami studies, the atmospheric pressure record will be applied as a correction to the water pressure record. Widespread use of the instrument in the Atlantic will also aid in gathering data for a closer study of the propagation charac-

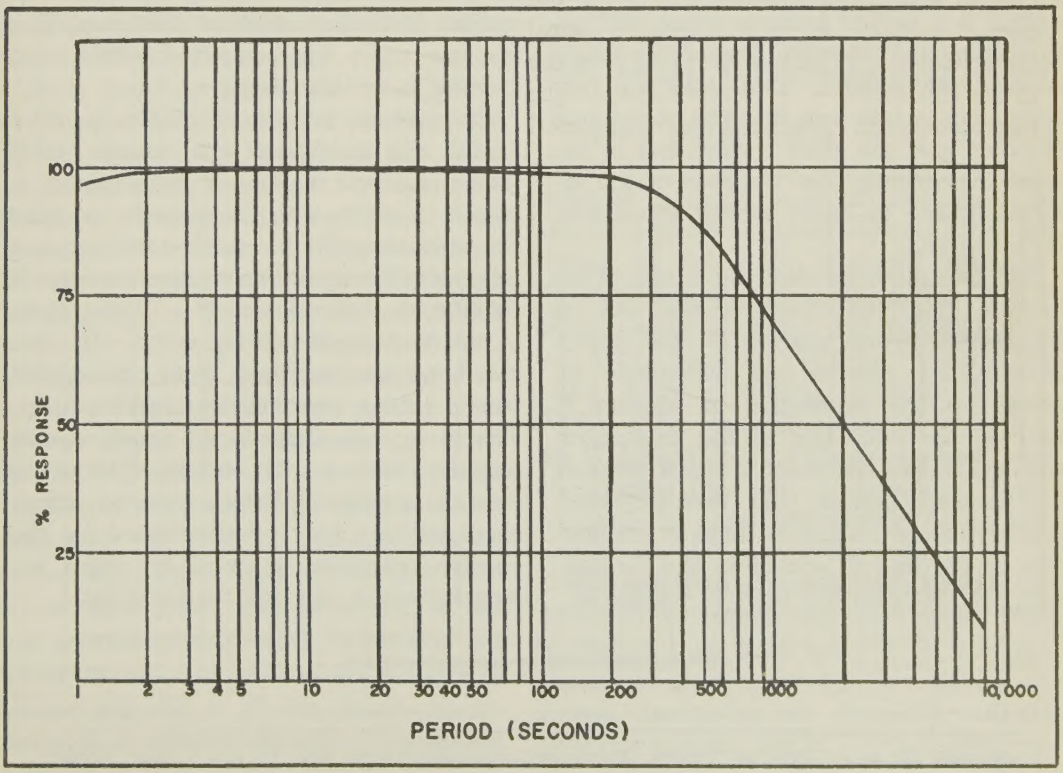

Fig. 10. *Typical Response Curve of Microbarovariograph Transducer.*

teristics of internal waves in the atmosphere.

Microbarovariographs are or will be installed in Iceland, the Azores, Bermuda, Barbados, Ascension, St. Helena, Texas Tower No. 4, and Fire Island, New York. Argentina plans to use two instruments in connection with its IGY program.

The microbarovariograph is a rate-of-change pressure recorder, utilizing a pressure transducer developed by Wallace of Wallace and Tiernan, Inc. The pressure transducer is essentially a U-tube manometer (see Fig. 7) open at one end to the dynamic pressure fluctuations of the atmosphere and at the other to a thermally insulated chamber maintaining a relatively constant temperature. The fluid used in the transducer is Di-Octal Sebacate, a commercial plasticizer, selected especially because of its small temperature coefficient of expansion and low volatility and creep. A saturated solution of calcium chloride is used to adjust the reference volume to a pre-determined value and to maintain within it a partial pressure which will aid in keeping the reference pressure as nearly constant as possible. Two leaks are provided, one a fast leak into the compliance chamber and the other a slow leak in the reference volume. The response of the instrument can be easily set by adjustment of these leaks.

Figure 8 shows an electrical analog of the system. Response characteristics can be determined by an analysis of this circuit. Short-period changes are effectively reduced by the connection of another U tube in the same line as the transducer, which dampens the effect of quick pressure fluctuations. Because the thermally-insulated reference volume is large in comparison to the pickup volume in the manometer, the temperature drift is negligible.

Figure 9 is a block diagram of the recording system. The armature of the pickup is connected to the float on the surface of the fluid in the transducer. The mechanical pressure fluctuations are converted into direct current by a simple electro-dynamic pickup. The d.c. signal produced modulates a 60-cycle alternating-current carrier. Following two stages of amplification, a demodulator converts the output signal to d.c., which drives a Lamont microfilm recorder. The feed-back circuit utilizes a magnetic modulator to return the d.c. output signal to a.c. The maximum resolution possible is about .002 mb. The approximate dynamic pressure range is 0.12 mb. The operating sensitivity used depends upon the resolution and the response desired, with the limitation that the slow leak must be capable of effectively eliminating all large diurnal pressure changes.

Figure 10 is a typical response curve of the transducer. Reference to the curve shows that it is relatively flat between 10 secs and approximately 200 secs. It reaches half value at about 2000 secs. The response curve was computed from a step impulse on the transducer.

Once set up with the microfilm recorder loaded, the instrument can operate unattended for one month. A panel meter is placed in series with the recorder so that the operation can be checked at frequent intervals. The instrument operates from a 50–60-cycle, 110-volt a.c. line. All the parts of the transducer housing except the outside cover are machined from plastic, and plastic tubing connects the various units. The three units (transducer, amplifier, and recorder) have a total weight of about 12 lbs. A standard Esterline-Angus strip-chart recorder may be substituted for the Lamont microfilm recorder by using alternate output plugs on the amplifier.

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